EXHIBIT 2

UNITED STATES PATENT NO. 6,711,204
CLAIM CHART FOR INFRINGEMENT OF REPRESENTATIVE CLAIMS 3, 25 AND 26

Note: This representative claim chart is provided solely for pleading purposes in this action and is based upon information known at this time. This chart does not represent Plaintiff's infringement contentions, the asserted claims, or all of Plaintiff's allegations regarding infringement. Plaintiff further reserves the right to assert additional or different theories of infringement, including infringement under the doctrine of equivalents.

Infringement analysis provided for any preamble should not be construed as an admission that such preamble is limiting.

Claim	Pi-CON AnyWAN GATEWAY (the accused product/instrumentality)
3. An improvement to a spread-spectrum system having a base station and a plurality of remote stations (RS), with said base station (BS) for transmitting a plurality of BS-spread-spectrum signals at a first frequency and for receiving,	The accused product (base station (BS)) connect devices like smartphones, laptops and/or tablets to the internet using the accused device's internet connection.Wi-Fi and/or Wi-Fi IEEE 802.11 standard uses b/g/n 2.4GHz and ac/a/n 5GHz ISM bands. The accused product supports both the bands. The IEEE 802.11b standard uses DSSS (Direct Sequence Spread Spectrum). The accused product transmits a plurality of BS-spread-spectrum signals at a first frequency defined by the 2.4GHz ISM band and/or the 5GHz band. The frequency used for the communication between the BS and the plurality of RS is defined by the IEEE 802.011 standard. The accused product acts as an access point (AP) and sends out beacon frames. The devices within the range receive the frames and use the frames to connect to the AP as per the connection parameters described in the frames. A Probe Response frame carries all the parameters in a beacon frame, which enables mobile stations to match parameters and join the network. These fields specify the channel frequency to be used and the spacing of the channel. Once the frequency measurement is complete, both the uplink and downlink communication takes place on the measured frequency.

at a second frequency, a plurality of RS-spread-spectrum signals transmitted from said plurality of remote stations, respectively, the improvement comprising:	 http://kgplogistics.com/ad_jump/docs/Pi-CON-Aug2017.pdf

Pi-CON

Product Features

Interfaces

4 x 1000BASE-TX Gigabit LAN ports
1 x 1000BASE-TX Gigabit WAN port
1 x SFP WAN port
1 x RJ11 xDSL port + 2 x RJ11 FXS ports (SIP)
2 x USB 3.0 ports

Wireless
802.11ac 5GHz 4x4 MU-MIMO WiFi Access Point
802.11n 2.4GHz 4x4 SU-MIMO WiFi Access Point
AnyClient™ beamforming for any 11a/b/g/n/ac device
Multiple SSIDs, including isolated Guest SSID
Wi-Fi QoS (WMM®) and WMM®- Power Save
Wi-Fi Protected Setup™ 2
WPA2, AES encryption
100% CPU Offload (Zero WiFi processing on CPU)
DFS (Dynamic Frequency Selection)
802.11k/r/v for Whole-home WiFi roaming assist

HTTP/HTTPS, SSH, and SNMP
Syslog logging (local/remote)
Real-time Status and Reporting
Remote/Live Updates
Configuration Backup and Restore
Custom Defaults & Themes

Security
Encapsulated Core, ISEC Intel Security
Stateful Packet Inspection Firewall
Denial of Service attack prevention
Malware blackholing
TCP/IP/Port/interface filtering rules

VoIP*
SIP/RTP/RTCP/SDP
Outbound Proxy
Fax/modem passthrough & ITU-T T.38 Fax Relay
RFC2833 DTMF tone detection/generation
ITU-T G.168 Echo Cancellation
Silence Supression (VAD-DTX-CNG)
G.711 μ-law and A-law codecs

http://kgplogistics.com/ad_jump/docs/Pi-CON-Aug2017.pdf

As shown below, the accused product supports Wi-Fi and acts as wireless access point:

	Pi-CON **Product Features** **Interfaces** 4 x 1000BASE-TX Gigabit LAN ports 1 x 1000BASE-TX Gigabit WAN port 1 x SFP WAN port 1 x RJ11 xDSL port + 2 x RJ11 FXS ports (SIP) 2 x USB 3.0 ports **Wireless** 802.11ac 5GHz 4x4 MU-MIMO WiFi Access Point 802.11n 2.4GHz 4x4 SU-MIMO WiFi Access Point AnyClient™ beamforming for any 11a/b/g/n/ac device Multiple SSIDs, including isolated Guest SSID Wi-Fi QoS (WMM®) and WMM®- Power Save Wi-Fi Protected Setup™ 2 WPA2, AES encryption 100% CPU Offload (Zero WiFi processing on CPU) DFS (Dynamic Frequency Selection) 802.11k/r/v for Whole-home WiFi roaming assist http://kgplogistics.com/ad_jump/docs/Pi-CON-Aug2017.pdf

	802.11b and 802.11g use the 2.4 GHz ISM band, operating in the United States under Part 15 of the U.S. Federal Communications Commission Rules and Regulations; 802.11n can also use that band. Because of this choice of frequency band, 802.11b/g/n equipment may occasionally suffer interference in the 2.4 GHz band from microwave ovens, cordless telephones, and Bluetooth devices etc. 802.11b and 802.11g control their interference and susceptibility to interference by using direct-sequence spread spectrum (DSSS) and orthogonal frequency-division multiplexing (OFDM) signaling methods, respectively. Source: https://en.wikipedia.org/wiki/IEEE_802.11 Wi-Fi IEEE 802.11 is used by very many devices from smartphones to laptops and tablets to remote sensors, actuators televisions and many more. There are several frequency bands within the radio spectrum that are used for the Wi-Fi and within these there are many channels that have been designated with numbers so they can be identified. Although many Wi-Fi channels are selected automatically, it sometimes helps to have an understanding of the Wi-Fi spectrum, bands, frequencies and the channels with their channel numbers to enable the best performance to be gained. When setting up a Wi-Fi network at home, in the office, or anywhere else, it can help to have a knowledge of the channels and bands available, so that successful Wi-Fi links can be established Also when office Wi-Fi access points are installed, it helps to understand the bands, their characteristics and the channels available. Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

Wi-Fi is aimed at use within unlicensed spectrum - the ISM or Industrial, Scientific and Medical bands. These bands have been internationally agreed and unlike most other bands, they can be used without the need for a transmitting licence. This gives access to everyone to use them freely.

The ISM bands are not only used by Wi-Fi, but everything from microwave ovens to many other forms of wireless connectivity and many industrial, scientific and medical uses.

Whilst the ISM bands are available globally, there are some differences and restrictions that can occur in some countries.

The main bands used for carrying Wi-Fi are those in the table below:

SUMMARY OF MAJOR ISM BANDS

LOWER FREQUENCY MHZ	UPPER FREQUENCY MHZ	COMMENTS
2400	2500	Often referred to as the 2.4 GHz band, this spectrum is the most widely used of the bands available for Wi-Fi. Used by 802.11b, g, & n. It can carry a maximum of three non-overlapping channels. This band is widely used by many other non-licensed items including microwave ovens, Bluetooth, etc.
5725	5875	This 5 GHz Wi-Fi band or to be more precise the 5.8 GHz band provides additional bandwidth, and being at a higher frequency, equipment costs are slightly higher, although usage, and hence interference is less.It can be used by 802.11a & n. It can carry up to 23 non-overlapping channels, but gives a shorter range than 2.4 GHz. 5GHz Wi-Fi is preferred by many because of the number of channels and the bandwidth available. There are also fewer other users of this band.

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

	2.4 GHz Wi-Fi channel frequencies The table given below provides the frequencies for the total of fourteen 802.11 Wi-Fi channels that are available around the globe. Not all of these channels are available for use in all countries. **2.4GHZ BAND CHANNEL NUMBERS & FREQUENCIES**

CHANNEL NUMBER	LOWER FREQUENCY MHZ	CENTER FREQUENCY MHZ	UPPER FREQUENCY MHZ
1	2401	2412	2423
2	2406	2417	2428
3	2411	2422	2433
4	2416	2427	2438
5	2421	2432	2443
6	2426	2437	2448
7	2431	2442	2453
8	2436	2447	2458
9	2441	2452	2463
10	2446	2457	2468
11	2451	2462	2473
12	2456	2467	2478
13	2461	2472	2483
14	2473	2484	2495

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

2.4 GHz Wi-Fi channel availability

In view of the differences in spectrum allocations around the globe and different requirements for the regulatory authorities, not all the WLAN channels are available in every country. The table below provides a broad indication of the availability of the different Wi-Fi channels in different parts of the world.

2.4 GHZ WI-FI CHANNEL AVAILABILITY

CHANNEL NUMBER	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
1	✓	✓	✓
2	✓	✓	✓
3	✓	✓	✓
4	✓	✓	✓
5	✓	✓	✓
6	✓	✓	✓
7	✓	✓	✓
8	✓	✓	✓
9	✓	✓	✓
10	✓	✓	✓
11	✓	✓	✓
12	✓	No	✓
13	✓	No	✓
14	No	No	802.11b only

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

5 GHZ WIFI CHANNELS & FREQUENCIES

CHANNEL NUMBER	FREQUENCY MHZ	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
36	5180	Indoors	✓	✓
40	5200	Indoors	✓	✓
44	5220	Indoors	✓	✓
48	5240	Indoors	✓	✓
52	5260	Indoors / DFS / TPC	DFS	DFS / TPC
56	5280	Indoors / DFS / TPC	DFS	DFS / TPC
60	5300	Indoors / DFS / TPC	DFS	DFS / TPC
64	5320	Indoors / DFS / TPC	DFS	DFS / TPC
100	5500	DFS / TPC	DFS	DFS / TPC
104	5520	DFS / TPC	DFS	DFS / TPC
108	5540	DFS / TPC	DFS	DFS / TPC
112	5560	DFS / TPC	DFS	DFS / TPC
116	5580	DFS / TPC	DFS	DFS / TPC
120	5600	DFS / TPC	No Access	DFS / TPC
124	5620	DFS / TPC	No Access	DFS / TPC
128	5640	DFS / TPC	No Access	DFS / TPC
132	5660	DFS / TPC	DFS	DFS / TPC
136	5680	DFS / TPC	DFS	DFS / TPC
140	5700	DFS / TPC	DFS	DFS / TPC
149	5745	SRD	✓	No Access
153	5765	SRD	✓	No Access
157	5785	SRD	✓	No Access
161	5805	SRD	✓	No Access
165	5825	SRD	✓	No Access

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

Connecting to the Network

The wireless host (station) needs to associate with an Access Point (AP) before it can send/receive network-layer data. This is a basic 802.11 system management function.

Association is the creation of a 'virtual' ethernet wire between the station and the switch.

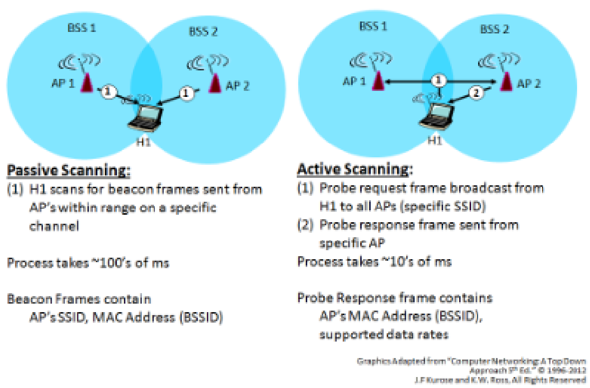
The basic three-step procedure followed by the station:

1. **Locate** an AP to associate with; this process can involve passive or active scanning as discussed below.
2. **Authenticate** itself to the AP (and possibly the infrastructure).
3. **Associate** with the AP (create the 'virtual' blue cable).

Now, the station can retrieve an IP address from the subnet and begin TCP/UDP socket communications.

Locate

The first step is to locate the AP you wish to join. The algorithm for locating/selecting an AP is not defined by the 802.11 standards, but by your application. There are two methods provided in 802.11 to discover APs near the station: **passive** and **active** scanning, which are illustrated below.



Source: https://microchipdeveloper.com/wifi:connecting

Beacon interval

Beacon transmissions announce the existence of an 802.11 network at regular intervals. Beacon frames carry information about the BSS parameters and the frames buffered by access points, so mobile stations must listen to Beacons. The Beacon Interval, shown in Figure 4-23, is a 16-bit field set to the number of *time units* between Beacon transmissions. One time unit, which is often abbreviated TU, is 1,024 microseconds (ms), which is about 1 millisecond.[22] Time units may also be called kilo-microseconds in various documentation (Kms or kms). It is common for the Beacon interval to be set to 100 time units, which corresponds to an interval between Beacon transmissions of approximately 100 milliseconds or 0.1 seconds.

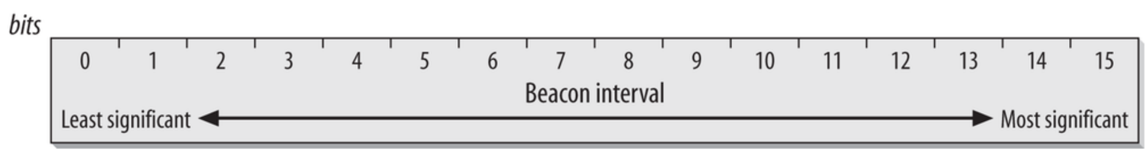


Figure 4-23. Beacon Interval field

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

Beacon

Beacon frames announce the existence of a network and are an important part of many network maintenance tasks. They are transmitted at regular intervals to allow mobile stations to find and identify a network, as well as match parameters for joining the network. In an infrastructure network, the access point is responsible for transmitting Beacon frames. The area in which Beacon frames appear defines the basic service area. All communication in an infrastructure network is done through an access point, so stations on the network must be close enough to hear the Beacons.

Figure 4-51 shows most the fields that can be used in a Beacon frame in the order in which they appear. Not all of the elements are present in all Beacons. Optional fields are present only when there is a reason for them to be used. The FH and DS Parameter Sets are used only when the underlying physical layer is based on frequency hopping or direct-sequence techniques. Only one physical layer can be in use at any point, so the FH and DS Parameter Sets are mutually exclusive.

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

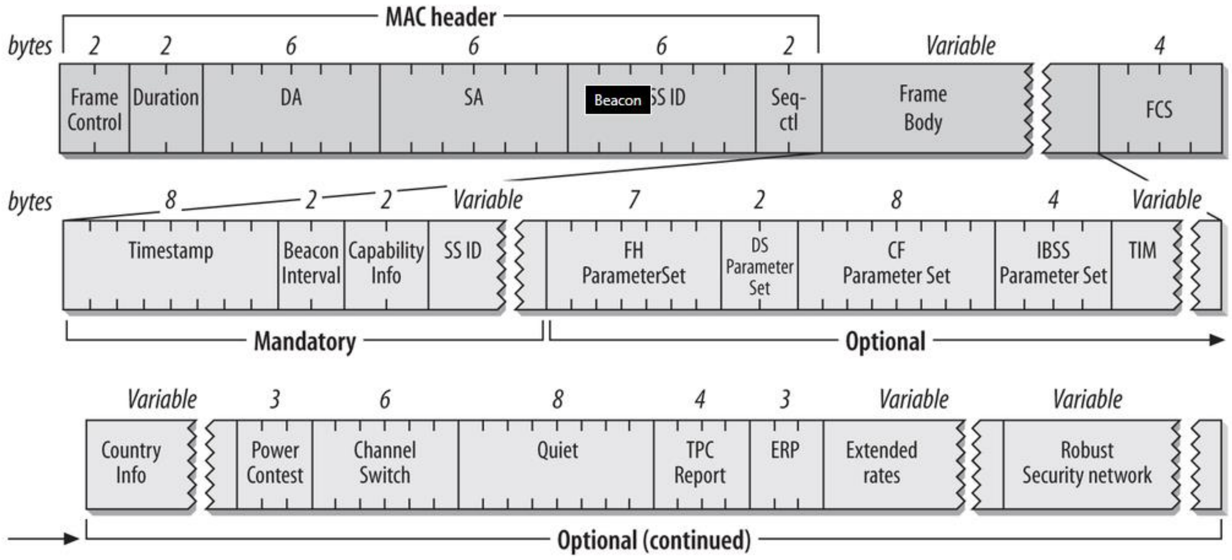


Figure 4-51. Beacon frame

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

Probe Response

If a Probe Request encounters a network with compatible parameters, the network sends a Probe Response frame. The station that sent the last Beacon is responsible for responding to incoming probes. In infrastructure networks, this station is the access point. In an IBSS, responsibility for Beacon transmission is distributed. After a station transmits a Beacon, it assumes responsibility for sending Probe Response frames for the next Beacon interval. The format of the Probe Response frame is shown in Figure 4-53. Some of the fields in the frame are mutually exclusive; the same rules apply to Probe Response frames as to Beacon frames.

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

<table>
<tr>
<td></td>
<td>

Country

The initial 802.11 specifications were designed around the existing regulatory constraints in place in the major industrialized countries. Rather than continue to revise the specification each time a new country was added, a new specification was added that provides a way for networks to describe regulatory constraints to new stations. The main pillar of this is the Country information element, shown in Figure 4-38.

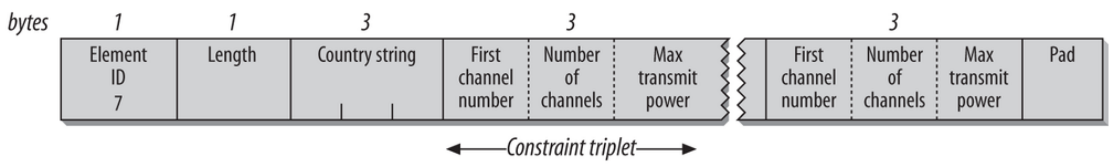


Figure 4-38. Country information element

After the initial type/length information element header, there is a country identifier, followed by a series of three-byte descriptors for regulatory constraints. Each constraint descriptor specifies a unique band, and they may not overlap, since a given frequency has only one maximum allowed power.

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

</td>
</tr>
<tr>
<td>said base station for transmitting a BS-channel-sounding signal at the second frequency;</td>
<td>The base station transmits beacon frames (sounding signals) to the devices nearby at the second frequency (measured/calculated frequency used for the uplink communication). The Power Constraint element included in the beacon frames allows a device (trying to connect to the base station) to determine the local maximum transmit power in the current channel being used for communication and describes the maximum transmit power to remote stations. The local maximum transmit power for a channel is defined as the maximum transmit power level specified for the channel in the Country element minus the local power constraint specified for the channel in the Power Constraint element.</td>
</tr>
</table>

Power Constraint

The Power Constraint information element is used to allow a network to describe the maximum transmit power to stations. In addition to a regulatory maximum, there may be another maximum in effect. The only field, a one-byte integer, is the number of decibels by which any local constraint reduces the regulatory maximum. If, for example, the regulatory maximum power were 10 dBm, but this information element contained the value 2, then the station would set its maximum transmit power to 8 dBm (Figure 4-41).

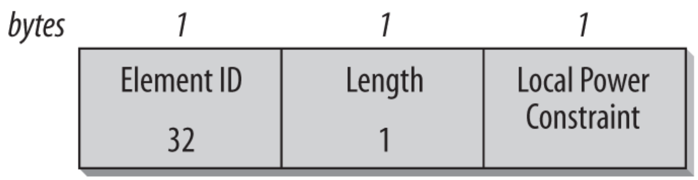


Figure 4-41. Power Constraint information element

Power Capability

802.11 stations are battery powered, and often have radios that are not as capable as access points, in part because there is not usually the need for mobile client devices to transmit at high power. The Power Capability information element allows a station to report its minimum and maximum transmit power, in integer units of dBm (Figure 4-42).

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

Country

The initial 802.11 specifications were designed around the existing regulatory constraints in place in the major industrialized countries. Rather than continue to revise the specification each time a new country was added, a new specification was added that provides a way for networks to describe regulatory constraints to new stations. The main pillar of this is the Country information element, shown in Figure 4-38.

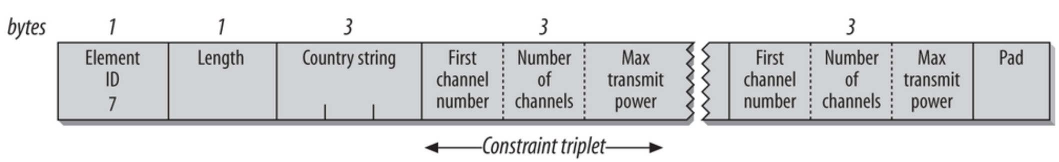


Figure 4-38. Country information element

	Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38 *First Channel Number (1 byte)* The first channel number is the lowest channel subject to the power constraint. Channel number assignment for each PHY is discussed in the appropriate chapter. *Number of Channels (1 byte)* The size of the band subject to the power constraint is indicated by the number of channels. The size of a channel is PHY-dependent. *Maximum Transmit Power (1 byte)* The maximum transmit power, expressed in dBm. *Pad (1 byte; optional)* The size of the information element must be an even number of bytes. If the length of the information element is an odd number of bytes, a single byte of zeroes is appended as a pad. Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

9.4.2.14 Power Constraint element

The Power Constraint element contains the information necessary to allow a STA to determine the local maximum transmit power in the current channel. The format of the Power Constraint element is shown in Figure 9-140.

	Element ID	Length	Local Power Constraint
Octets:	1	1	1

Figure 9-140—Power Constraint element format

The Element ID and Length fields are defined in 9.4.2.1.

The Local Power Constraint field is coded as an unsigned integer in units of decibels. The local maximum transmit power for a channel is thus defined as the maximum transmit power level specified for the channel in the Country element minus the local power constraint specified for the channel (from the MIB) in the Power Constraint element.

The Power Constraint element is included in Beacon frames, as described in 9.3.3.3, and Probe Response frames, as described in 9.3.3.11. The use of Power Constraint elements is described in 11.8.5.

9.4.2.15 Power Capability element

The Power Capability element specifies the minimum and maximum transmit powers with which a STA is capable of transmitting in the current channel. The format of the Power Capability element is shown in Figure 9-141.

	Element ID	Length	Minimum Transmit Power Capability	Maximum Transmit Power Capability
Octets:	1	1	1	1

Source: http://read.pudn.com/downloads117/ebook/497259/802.11h-2003.pdf , page 27

	The Minimum Transmit Power Capability field is set to the nominal minimum transmit power with which the STA is capable of transmitting in the current channel, with a tolerance ± 5 dB. The field is coded as a signed integer in units of decibels relative to 1 mW. Further interpretation of this field is defined in 11.8.4. The Maximum Transmit Power Capability field is set to the nominal maximum transmit power with which the STA is capable of transmitting in the current channel, with a tolerance ± 5 dB. The field is coded as a signed integer in units of decibels relative to 1 mW. Further interpretation of this field is defined in 11.8.4. The Power Capability element is included in Association Request frames, as described in 9.3.3.6; Reassociation Request frames, as described in 9.3.3.8; and Mesh Peering Open frame, as described in 9.6.16.2.2. The use of Power Capability elements is described in 11.8.2. Source: http://read.pudn.com/downloads117/ebook/497259/802.11h-2003.pdf , page 28
said plurality of remote stations for receiving the BS-channel-sounding signal at the second frequency, with said base station for transmitting the plurality of BS-spread-spectrum signals at the first frequency outside a correlation bandwidth of	802.11 standard is a half-duplex technology. Hence, a remote station can either receive or transmit at a given time. This implies that when a remote station receives the sounding signal at the second frequency it is not transmitting at the first frequency. Hence, the BS transmits plurality of BS-spread-spectrum signals at a first frequency outside a correlation bandwidth of the plurality of RS-spread-spectrum signals transmitted by plurality of remote stations at a second frequency. **How Duplexing Affects WiFi Routers** WiFi routers are devices that modulate and schedule the flow of information to and from any WiFi-capable electronic device (like a laptop or smartphone) to the Internet, using a specific standard or protocol called IEEE 802.11 which works at half-duplex. WiFi is just the trademark brand for this specific **IEEE** standard (**understand the common WiFi standards**). Source: https://www.makeuseof.com/tag/what-is-half-duplex-and-full-duplex-operation-and-how-does-it-affect-your-router/

the plurality of RS-spread-spectrum signals transmitted by the plurality of remote stations at the second frequency; and	Wi-Fi IEEE 802.11 is used by very many devices from smartphones to laptops and tablets to remote sensors, actuators televisions and many more. There are several frequency bands within the radio spectrum that are used for the Wi-Fi and within these there are many channels that have been designated with numbers so they can be identified. Although many Wi-Fi channels are selected automatically, it sometimes helps to have an understanding of the Wi-Fi spectrum, bands, frequencies and the channels with their channel numbers to enable the best performance to be gained. When setting up a Wi-Fi network at home, in the office, or anywhere else, it can help to have a knowledge of the channels and bands available, so that successful Wi-Fi links can be established Also when office Wi-Fi access points are installed, it helps to understand the bands, their characteristics and the channels available. Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

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The ISM bands are not only used by Wi-Fi, but everything from microwave ovens to many other forms of wireless connectivity and many industrial, scientific and medical uses.

Whilst the ISM bands are available globally, there are some differences and restrictions that can occur in some countries.

The main bands used for carrying Wi-Fi are those in the table below:

SUMMARY OF MAJOR ISM BANDS

LOWER FREQUENCY MHZ	UPPER FREQUENCY MHZ	COMMENTS
2400	2500	Often referred to as the 2.4 GHz band, this spectrum is the most widely used of the bands available for Wi-Fi. Used by 802.11b, g, & n. It can carry a maximum of three non-overlapping channels. This band is widely used by many other non-licensed items including microwave ovens, Bluetooth, etc.
5725	5875	This 5 GHz Wi-Fi band or to be more precise the 5.8 GHz band provides additional bandwidth, and being at a higher frequency, equipment costs are slightly higher, although usage, and hence interference is less.It can be used by 802.11a & n. It can carry up to 23 non-overlapping channels, but gives a shorter range than 2.4 GHz. 5GHz Wi-Fi is preferred by many because of the number of channels and the bandwidth available. There are also fewer other users of this band.

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

2.4 GHz Wi-Fi channel frequencies

The table given below provides the frequencies for the total of fourteen 802.11 Wi-Fi channels that are available around the globe. Not all of these channels are available for use in all countries.

2.4GHZ BAND CHANNEL NUMBERS & FREQUENCIES

CHANNEL NUMBER	LOWER FREQUENCY MHZ	CENTER FREQUENCY MHZ	UPPER FREQUENCY MHZ
1	2401	2412	2423
2	2406	2417	2428
3	2411	2422	2433
4	2416	2427	2438
5	2421	2432	2443
6	2426	2437	2448
7	2431	2442	2453
8	2436	2447	2458
9	2441	2452	2463
10	2446	2457	2468
11	2451	2462	2473
12	2456	2467	2478
13	2461	2472	2483
14	2473	2484	2495

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

2.4 GHz Wi-Fi channel availability

In view of the differences in spectrum allocations around the globe and different requirements for the regulatory authorities, not all the WLAN channels are available in every country. The table below provides a broad indication of the availability of the different Wi-Fi channels in different parts of the world.

2.4 GHZ WI-FI CHANNEL AVAILABILITY

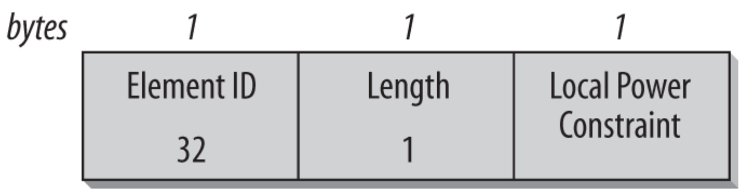
CHANNEL NUMBER	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
1	✓	✓	✓
2	✓	✓	✓
3	✓	✓	✓
4	✓	✓	✓
5	✓	✓	✓
6	✓	✓	✓
7	✓	✓	✓
8	✓	✓	✓
9	✓	✓	✓
10	✓	✓	✓
11	✓	✓	✓
12	✓	No	✓
13	✓	No	✓
14	No	No	802.11b only

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

	5 GHZ WIFI CHANNELS & FREQUENCIES (table below) Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php
said plurality of remote stations, responsive to	The base station transmits beacon frames (sounding signal) to the devices nearby at the second frequency (measured/calculated frequency used for the uplink communication). The Power Constraint element included in the beacon frames allows a device (trying to connect to the base station) to determine the local maximum transmit power in the current channel being used for communication and describes the maximum transmit power to remote stations.

5 GHZ WIFI CHANNELS & FREQUENCIES

CHANNEL NUMBER	FREQUENCY MHZ	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
36	5180	Indoors	✓	✓
40	5200	Indoors	✓	✓
44	5220	Indoors	✓	✓
48	5240	Indoors	✓	✓
52	5260	Indoors / DFS / TPC	DFS	DFS / TPC
56	5280	Indoors / DFS / TPC	DFS	DFS / TPC
60	5300	Indoors / DFS / TPC	DFS	DFS / TPC
64	5320	Indoors / DFS / TPC	DFS	DFS / TPC
100	5500	DFS / TPC	DFS	DFS / TPC
104	5520	DFS / TPC	DFS	DFS / TPC
108	5540	DFS / TPC	DFS	DFS / TPC
112	5560	DFS / TPC	DFS	DFS / TPC
116	5580	DFS / TPC	DFS	DFS / TPC
120	5600	DFS / TPC	No Access	DFS / TPC
124	5620	DFS / TPC	No Access	DFS / TPC
128	5640	DFS / TPC	No Access	DFS / TPC
132	5660	DFS / TPC	DFS	DFS / TPC
136	5680	DFS / TPC	DFS	DFS / TPC
140	5700	DFS / TPC	DFS	DFS / TPC
149	5745	SRD	✓	No Access
153	5765	SRD	✓	No Access
157	5785	SRD	✓	No Access
161	5805	SRD	✓	No Access
165	5825	SRD	✓	No Access

the BS-channel-sounding signal, for adjusting an initial RS-power level of said plurality of remote stations.	The local maximum transmit power for a channel is defined as the maximum transmit power level specified for the channel in the Country element minus the local power constraint specified for the channel in the Power Constraint element. **Power Constraint** The Power Constraint information element is used to allow a network to describe the maximum transmit power to stations. In addition to a regulatory maximum, there may be another maximum in effect. The only field, a one-byte integer, is the number of decibels by which any local constraint reduces the regulatory maximum. If, for example, the regulatory maximum power were 10 dBm, but this information element contained the value 2, then the station would set its maximum transmit power to 8 dBm (Figure 4-41).  *Figure 4-41. Power Constraint information element* **Power Capability** 802.11 stations are battery powered, and often have radios that are not as capable as access points, in part because there is not usually the need for mobile client devices to transmit at high power. The Power Capability information element allows a station to report its minimum and maximum transmit power, in integer units of dBm (Figure 4-42). Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

Country

The initial 802.11 specifications were designed around the existing regulatory constraints in place in the major industrialized countries. Rather than continue to revise the specification each time a new country was added, a new specification was added that provides a way for networks to describe regulatory constraints to new stations. The main pillar of this is the Country information element, shown in Figure 4-38.

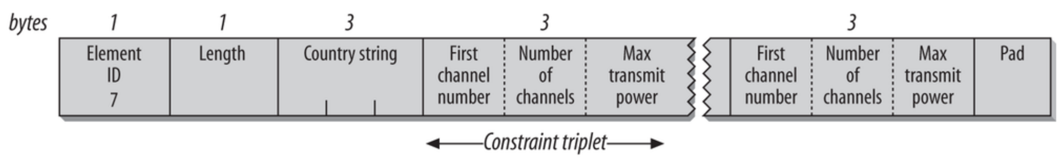


Figure 4-38. Country information element

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

First Channel Number (1 byte)

The first channel number is the lowest channel subject to the power constraint. Channel number assignment for each PHY is discussed in the appropriate chapter.

Number of Channels (1 byte)

The size of the band subject to the power constraint is indicated by the number of channels. The size of a channel is PHY-dependent.

Maximum Transmit Power (1 byte)

The maximum transmit power, expressed in dBm.

Pad (1 byte; optional)

The size of the information element must be an even number of bytes. If the length of the information element is an odd number of bytes, a single byte of zeroes is appended as a pad.

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

9.4.2.14 Power Constraint element

The Power Constraint element contains the information necessary to allow a STA to determine the local maximum transmit power in the current channel. The format of the Power Constraint element is shown in Figure 9-140.

	Element ID	Length	Local Power Constraint
Octets:	1	1	1

Figure 9-140—Power Constraint element format

The Element ID and Length fields are defined in 9.4.2.1.

The Local Power Constraint field is coded as an unsigned integer in units of decibels. The local maximum transmit power for a channel is thus defined as the maximum transmit power level specified for the channel in the Country element minus the local power constraint specified for the channel (from the MIB) in the Power Constraint element.

The Power Constraint element is included in Beacon frames, as described in 9.3.3.3, and Probe Response frames, as described in 9.3.3.11. The use of Power Constraint elements is described in 11.8.5.

9.4.2.15 Power Capability element

The Power Capability element specifies the minimum and maximum transmit powers with which a STA is capable of transmitting in the current channel. The format of the Power Capability element is shown in Figure 9-141.

	Element ID	Length	Minimum Transmit Power Capability	Maximum Transmit Power Capability
Octets:	1	1	1	1

Source: http://read.pudn.com/downloads117/ebook/497259/802.11h-2003.pdf , page 27

	The Minimum Transmit Power Capability field is set to the nominal minimum transmit power with which the STA is capable of transmitting in the current channel, with a tolerance ± 5 dB. The field is coded as a signed integer in units of decibels relative to 1 mW. Further interpretation of this field is defined in 11.8.4. The Maximum Transmit Power Capability field is set to the nominal maximum transmit power with which the STA is capable of transmitting in the current channel, with a tolerance ± 5 dB. The field is coded as a signed integer in units of decibels relative to 1 mW. Further interpretation of this field is defined in 11.8.4. The Power Capability element is included in Association Request frames, as described in 9.3.3.6; Reassociation Request frames, as described in 9.3.3.8; and Mesh Peering Open frame, as described in 9.6.16.2.2. The use of Power Capability elements is described in 11.8.2. Source: http://read.pudn.com/downloads117/ebook/497259/802.11h-2003.pdf , page 28
25. An improvement to a spread-spectrum method having a base station and a plurality of remote stations (RS), comprising the steps of: transmitting, from said base station, a plurality of BS-spread-spectrum signals at a first frequency;	The accused product (base station (BS)) provides wireless hotspot to connect devices like smartphones, laptops and/or tablets to the internet using the accused device's internet connection. A mobile hotspot on the accused product shares the internet connection via Wi-Fi technology with nearby devices such as smartphones, tablets, or other devices (plurality of remote stations (RS)) using Wi-Fi technology. Wi-Fi and/or Wi-Fi IEEE 802.11 standard uses b/g/n 2.4GHz and ac/a/n 5GHz ISM bands. The accused product supports both the bands. The IEEE 802.11b standard uses DSSS (Direct Sequence Spread Spectrum). The accused product transmits a plurality of BS-spread-spectrum signals at a first frequency defined by the 2.4GHz ISM band and/or the 5GHz band. The frequency used for the communication between the BS and the plurality of RS is defined by the IEEE 802.011 standard. When a hotspot is created, it acts as an access point (AP) and sends out beacon frames. The devices within the range receive the frames and use the frames to connect to the AP as per the connection parameters described in the frames. A Probe Response frame carries all the parameters in a beacon frame, which enables mobile stations to match parameters and join the network. These fields specify the channel frequency to be used and the spacing of the channel. Once the frequency measurement is complete, both the uplink and downlink communication takes place on the measured frequency.

transmitting, from said plurality of remote stations, a plurality of RS-spread-spectrum signals; receiving, at said base station, at a second frequency, the plurality of RS-spread-spectrum signals transmitted from said plurality of remote stations, respectively;	 http://kgplogistics.com/ad_jump/docs/Pi-CON-Aug2017.pdf As shown below, the accused product supports Wi-Fi and acts as wireless access point:

Pi-CON

Product Features

Interfaces

4 x 1000BASE-TX Gigabit LAN ports
1 x 1000BASE-TX Gigabit WAN port
1 x SFP WAN port
1 x RJ11 xDSL port + 2 x RJ11 FXS ports (SIP)
2 x USB 3.0 ports

Wireless
802.11ac 5GHz 4x4 MU-MIMO WiFi Access Point
802.11n 2.4GHz 4x4 SU-MIMO WiFi Access Point
AnyClient™ beamforming for any 11a/b/g/n/ac device
Multiple SSIDs, including isolated Guest SSID
Wi-Fi QoS (WMM®) and WMM®- Power Save
Wi-Fi Protected Setup™ 2
WPA2, AES encryption
100% CPU Offload (Zero WiFi processing on CPU)
DFS (Dynamic Frequency Selection)
802.11k/r/v for Whole-home WiFi roaming assist

HTTP/HTTPS, SSH, and SNMP
Syslog logging (local/remote)
Real-time Status and Reporting
Remote/Live Updates
Configuration Backup and Restore
Custom Defaults & Themes

Security
Encapsulated Core, ISEC Intel Security
Stateful Packet Inspection Firewall
Denial of Service attack prevention
Malware blackholing
TCP/IP/Port/interface filtering rules

VoIP*
SIP/RTP/RTCP/SDP
Outbound Proxy
Fax/modem passthrough & ITU-T T.38 Fax Relay
RFC2833 DTMF tone detection/generation
ITU-T G.168 Echo Cancellation
Silence Supression (VAD-DTX-CNG)
G.711 μ-law and A-law codecs

http://kgplogistics.com/ad_jump/docs/Pi-CON-Aug2017.pdf

	802.11b and 802.11g use the 2.4 GHz ISM band, operating in the United States under Part 15 of the U.S. Federal Communications Commission Rules and Regulations; 802.11n can also use that band. Because of this choice of frequency band, 802.11b/g/n equipment may occasionally suffer interference in the 2.4 GHz band from microwave ovens, cordless telephones, and Bluetooth devices etc. 802.11b and 802.11g control their interference and susceptibility to interference by using direct-sequence spread spectrum (DSSS) and orthogonal frequency-division multiplexing (OFDM) signaling methods, respectively. Source: https://en.wikipedia.org/wiki/IEEE_802.11 Wi-Fi IEEE 802.11 is used by very many devices from smartphones to laptops and tablets to remote sensors, actuators televisions and many more. There are several frequency bands within the radio spectrum that are used for the Wi-Fi and within these there are many channels that have been designated with numbers so they can be identified. Although many Wi-Fi channels are selected automatically, it sometimes helps to have an understanding of the Wi-Fi spectrum, bands, frequencies and the channels with their channel numbers to enable the best performance to be gained. When setting up a Wi-Fi network at home, in the office, or anywhere else, it can help to have a knowledge of the channels and bands available, so that successful Wi-Fi links can be established Also when office Wi-Fi access points are installed, it helps to understand the bands, their characteristics and the channels available. Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

	Wi-Fi is aimed at use within unlicensed spectrum - the ISM or Industrial, Scientific and Medical bands. These bands have been internationally agreed and unlike most other bands, they can be used without the need for a transmitting licence. This gives access to everyone to use them freely. The ISM bands are not only used by Wi-Fi, but everything from microwave ovens to many other forms of wireless connectivity and many industrial, scientific and medical uses. Whilst the ISM bands are available globally, there are some differences and restrictions that can occur in some countries. The main bands used for carrying Wi-Fi are those in the table below: **SUMMARY OF MAJOR ISM BANDS** **LOWER FREQUENCY MHZ** / **UPPER FREQUENCY MHZ** / **COMMENTS** 2400 / 2500 / Often referred to as the 2.4 GHz band, this spectrum is the most widely used of the bands available for Wi-Fi. Used by 802.11b, g, & n. It can carry a maximum of three non-overlapping channels. This band is widely used by many other non-licensed items including microwave ovens, Bluetooth, etc. 5725 / 5875 / This 5 GHz Wi-Fi band or to be more precise the 5.8 GHz band provides additional bandwidth, and being at a higher frequency, equipment costs are slightly higher, although usage, and hence interference is less.It can be used by 802.11a & n. It can carry up to 23 non-overlapping channels, but gives a shorter range than 2.4 GHz. 5GHz Wi-Fi is preferred by many because of the number of channels and the bandwidth available. There are also fewer other users of this band. Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

2.4 GHz Wi-Fi channel frequencies

The table given below provides the frequencies for the total of fourteen 802.11 Wi-Fi channels that are available around the globe. Not all of these channels are available for use in all countries.

2.4GHZ BAND CHANNEL NUMBERS & FREQUENCIES

CHANNEL NUMBER	LOWER FREQUENCY MHZ	CENTER FREQUENCY MHZ	UPPER FREQUENCY MHZ
1	2401	2412	2423
2	2406	2417	2428
3	2411	2422	2433
4	2416	2427	2438
5	2421	2432	2443
6	2426	2437	2448
7	2431	2442	2453
8	2436	2447	2458
9	2441	2452	2463
10	2446	2457	2468
11	2451	2462	2473
12	2456	2467	2478
13	2461	2472	2483
14	2473	2484	2495

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

2.4 GHz Wi-Fi channel availability

In view of the differences in spectrum allocations around the globe and different requirements for the regulatory authorities, not all the WLAN channels are available in every country. The table below provides a broad indication of the availability of the different Wi-Fi channels in different parts of the world.

2.4 GHZ WI-FI CHANNEL AVAILABILITY

CHANNEL NUMBER	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
1	✓	✓	✓
2	✓	✓	✓
3	✓	✓	✓
4	✓	✓	✓
5	✓	✓	✓
6	✓	✓	✓
7	✓	✓	✓
8	✓	✓	✓
9	✓	✓	✓
10	✓	✓	✓
11	✓	✓	✓
12	✓	No	✓
13	✓	No	✓
14	No	No	802.11b only

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

5 GHZ WIFI CHANNELS & FREQUENCIES

CHANNEL NUMBER	FREQUENCY MHZ	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
36	5180	Indoors	✓	✓
40	5200	Indoors	✓	✓
44	5220	Indoors	✓	✓
48	5240	Indoors	✓	✓
52	5260	Indoors / DFS / TPC	DFS	DFS / TPC
56	5280	Indoors / DFS / TPC	DFS	DFS / TPC
60	5300	Indoors / DFS / TPC	DFS	DFS / TPC
64	5320	Indoors / DFS / TPC	DFS	DFS / TPC
100	5500	DFS / TPC	DFS	DFS / TPC
104	5520	DFS / TPC	DFS	DFS / TPC
108	5540	DFS / TPC	DFS	DFS / TPC
112	5560	DFS / TPC	DFS	DFS / TPC
116	5580	DFS / TPC	DFS	DFS / TPC
120	5600	DFS / TPC	No Access	DFS / TPC
124	5620	DFS / TPC	No Access	DFS / TPC
128	5640	DFS / TPC	No Access	DFS / TPC
132	5660	DFS / TPC	DFS	DFS / TPC
136	5680	DFS / TPC	DFS	DFS / TPC
140	5700	DFS / TPC	DFS	DFS / TPC
149	5745	SRD	✓	No Access
153	5765	SRD	✓	No Access
157	5785	SRD	✓	No Access
161	5805	SRD	✓	No Access
165	5825	SRD	✓	No Access

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

Connecting to the Network

The wireless host (station) needs to associate with an Access Point (AP) before it can send/receive network-layer data. This is a basic 802.11 system management function.

Association is the creation of a 'virtual' ethernet wire between the station and the switch.

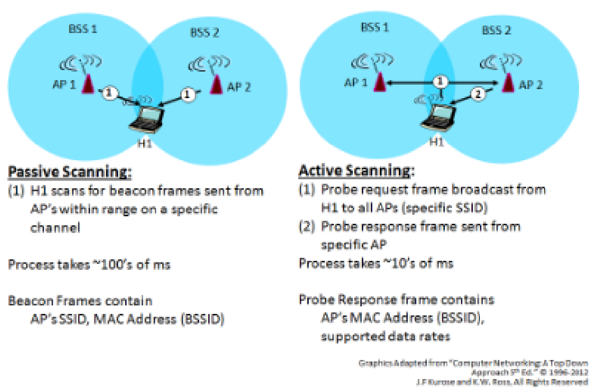
The basic three-step procedure followed by the station:

1. **Locate** an AP to associate with; this process can involve passive or active scanning as discussed below.
2. **Authenticate** itself to the AP (and possibly the infrastructure).
3. **Associate** with the AP (create the 'virtual' blue cable).

Now, the station can retrieve an IP address from the subnet and begin TCP/UDP socket communications.

Locate

The first step is to locate the AP you wish to join. The algorithm for locating/selecting an AP is not defined by the 802.11 standards, but by your application. There are two methods provided in 802.11 to discover APs near the station: **passive** and **active** scanning, which are illustrated below.



Source: https://microchipdeveloper.com/wifi:connecting

Beacon interval

Beacon transmissions announce the existence of an 802.11 network at regular intervals. Beacon frames carry information about the BSS parameters and the frames buffered by access points, so mobile stations must listen to Beacons. The Beacon Interval, shown in Figure 4-23, is a 16-bit field set to the number of *time units* between Beacon transmissions. One time unit, which is often abbreviated TU, is 1,024 microseconds (ms), which is about 1 millisecond.[22] Time units may also be called kilo-microseconds in various documentation (Kms or kms). It is common for the Beacon interval to be set to 100 time units, which corresponds to an interval between Beacon transmissions of approximately 100 milliseconds or 0.1 seconds.

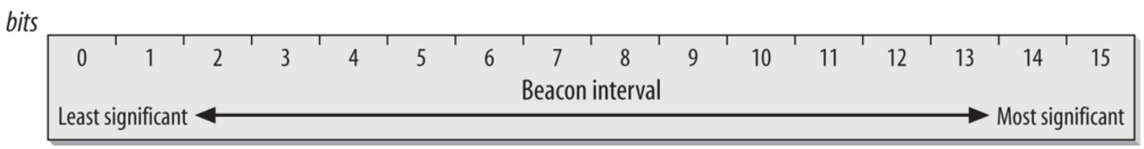


Figure 4-23. Beacon Interval field

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

Beacon

Beacon frames announce the existence of a network and are an important part of many network maintenance tasks. They are transmitted at regular intervals to allow mobile stations to find and identify a network, as well as match parameters for joining the network. In an infrastructure network, the access point is responsible for transmitting Beacon frames. The area in which Beacon frames appear defines the basic service area. All communication in an infrastructure network is done through an access point, so stations on the network must be close enough to hear the Beacons.

Figure 4-51 shows most the fields that can be used in a Beacon frame in the order in which they appear. Not all of the elements are present in all Beacons. Optional fields are present only when there is a reason for them to be used. The FH and DS Parameter Sets are used only when the underlying physical layer is based on frequency hopping or direct-sequence techniques. Only one physical layer can be in use at any point, so the FH and DS Parameter Sets are mutually exclusive.

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

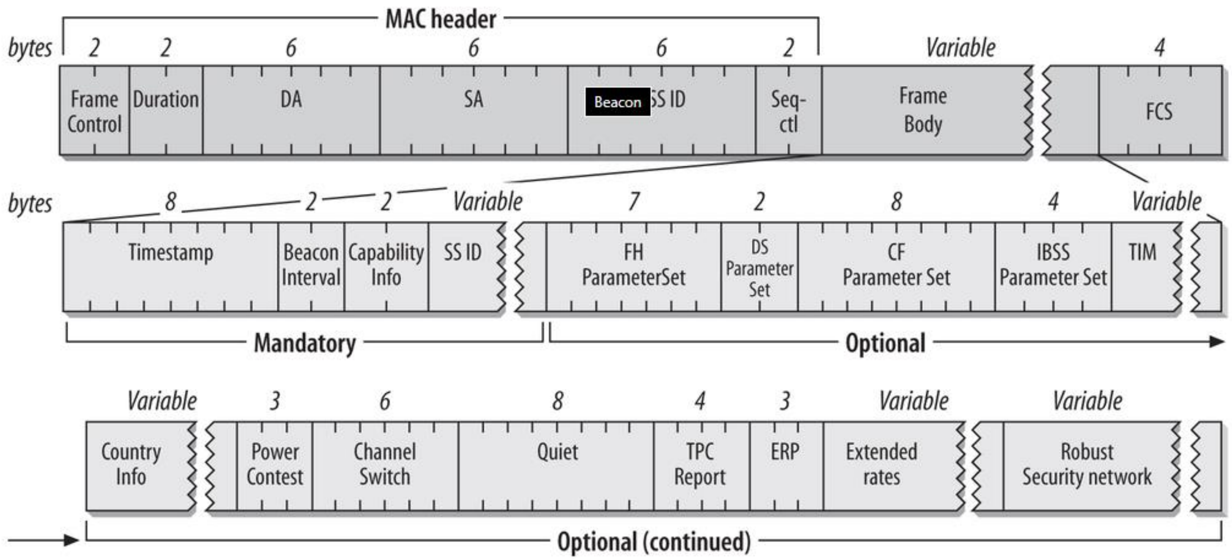


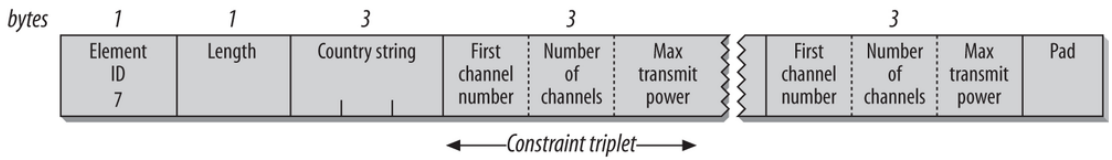
Figure 4-51. Beacon frame

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

Probe Response

If a Probe Request encounters a network with compatible parameters, the network sends a Probe Response frame. The station that sent the last Beacon is responsible for responding to incoming probes. In infrastructure networks, this station is the access point. In an IBSS, responsibility for Beacon transmission is distributed. After a station transmits a Beacon, it assumes responsibility for sending Probe Response frames for the next Beacon interval. The format of the Probe Response frame is shown in Figure 4-53. Some of the fields in the frame are mutually exclusive; the same rules apply to Probe Response frames as to Beacon frames.

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

	Country The initial 802.11 specifications were designed around the existing regulatory constraints in place in the major industrialized countries. Rather than continue to revise the specification each time a new country was added, a new specification was added that provides a way for networks to describe regulatory constraints to new stations. The main pillar of this is the Country information element, shown in Figure 4-38.  *Figure 4-38. Country information element* After the initial type/length information element header, there is a country identifier, followed by a series of three-byte descriptors for regulatory constraints. Each constraint descriptor specifies a unique band, and they may not overlap, since a given frequency has only one maximum allowed power. Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38
transmitting, from said base station, a BS-channel-sounding signal at the second frequency;	The base station transmits beacon frames (sounding signals) to the devices nearby at the second frequency (measured/calculated frequency used for the uplink communication). The Power Constraint element included in the beacon frames allows a device (trying to connect to the base station) to determine the local maximum transmit power in the current channel being used for communication and describes the maximum transmit power to remote stations. The local maximum transmit power for a channel is defined as the maximum transmit power level specified for the channel in the Country element minus the local power constraint specified for the channel in the Power Constraint element.

Power Constraint

The Power Constraint information element is used to allow a network to describe the maximum transmit power to stations. In addition to a regulatory maximum, there may be another maximum in effect. The only field, a one-byte integer, is the number of decibels by which any local constraint reduces the regulatory maximum. If, for example, the regulatory maximum power were 10 dBm, but this information element contained the value 2, then the station would set its maximum transmit power to 8 dBm (Figure 4-41).

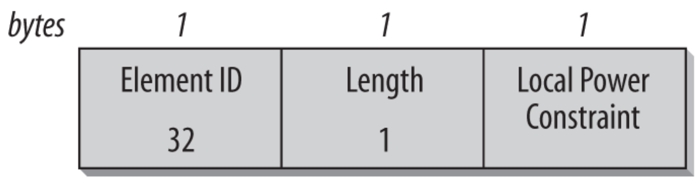


Figure 4-41. Power Constraint information element

Power Capability

802.11 stations are battery powered, and often have radios that are not as capable as access points, in part because there is not usually the need for mobile client devices to transmit at high power. The Power Capability information element allows a station to report its minimum and maximum transmit power, in integer units of dBm (Figure 4-42).

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

Country

The initial 802.11 specifications were designed around the existing regulatory constraints in place in the major industrialized countries. Rather than continue to revise the specification each time a new country was added, a new specification was added that provides a way for networks to describe regulatory constraints to new stations. The main pillar of this is the Country information element, shown in Figure 4-38.

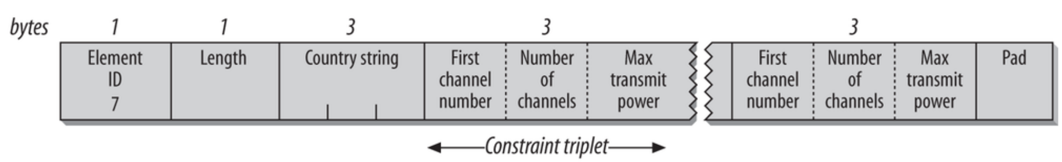


Figure 4-38. Country information element

	Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38 *First Channel Number (1 byte)* The first channel number is the lowest channel subject to the power constraint. Channel number assignment for each PHY is discussed in the appropriate chapter. *Number of Channels (1 byte)* The size of the band subject to the power constraint is indicated by the number of channels. The size of a channel is PHY-dependent. *Maximum Transmit Power (1 byte)* The maximum transmit power, expressed in dBm. *Pad (1 byte; optional)* The size of the information element must be an even number of bytes. If the length of the information element is an odd number of bytes, a single byte of zeroes is appended as a pad. Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

9.4.2.14 Power Constraint element

The Power Constraint element contains the information necessary to allow a STA to determine the local maximum transmit power in the current channel. The format of the Power Constraint element is shown in Figure 9-140.

	Element ID	Length	Local Power Constraint
Octets:	1	1	1

Figure 9-140—Power Constraint element format

The Element ID and Length fields are defined in 9.4.2.1.

The Local Power Constraint field is coded as an unsigned integer in units of decibels. The local maximum transmit power for a channel is thus defined as the maximum transmit power level specified for the channel in the Country element minus the local power constraint specified for the channel (from the MIB) in the Power Constraint element.

The Power Constraint element is included in Beacon frames, as described in 9.3.3.3, and Probe Response frames, as described in 9.3.3.11. The use of Power Constraint elements is described in 11.8.5.

9.4.2.15 Power Capability element

The Power Capability element specifies the minimum and maximum transmit powers with which a STA is capable of transmitting in the current channel. The format of the Power Capability element is shown in Figure 9-141.

	Element ID	Length	Minimum Transmit Power Capability	Maximum Transmit Power Capability
Octets:	1	1	1	1

Source: http://read.pudn.com/downloads117/ebook/497259/802.11h-2003.pdf , page 27

	The Minimum Transmit Power Capability field is set to the nominal minimum transmit power with which the STA is capable of transmitting in the current channel, with a tolerance ± 5 dB. The field is coded as a signed integer in units of decibels relative to 1 mW. Further interpretation of this field is defined in 11.8.4. The Maximum Transmit Power Capability field is set to the nominal maximum transmit power with which the STA is capable of transmitting in the current channel, with a tolerance ± 5 dB. The field is coded as a signed integer in units of decibels relative to 1 mW. Further interpretation of this field is defined in 11.8.4. The Power Capability element is included in Association Request frames, as described in 9.3.3.6; Reassociation Request frames, as described in 9.3.3.8; and Mesh Peering Open frame, as described in 9.6.16.2.2. The use of Power Capability elements is described in 11.8.2. Source: http://read.pudn.com/downloads117/ebook/497259/802.11h-2003.pdf , page 28
receiving, at said plurality of remote stations, the BS-channel-sounding signal at the second frequency; and	802.11 standard is a half-duplex technology. Hence, a remote station can either receive or transmit at a given time. This implies that when a remote station receives the sounding signal at the second frequency it is not transmitting at the first frequency. **How Duplexing Affects WiFi Routers** WiFi routers are devices that modulate and schedule the flow of information to and from any WiFi-capable electronic device (like a laptop or smartphone) to the Internet, using a specific standard or protocol called IEEE 802.11 which works at half-duplex. WiFi is just the trademark brand for this specific **IEEE** standard (**understand the common WiFi standards**). Source: https://www.makeuseof.com/tag/what-is-half-duplex-and-full-duplex-operation-and-how-does-it-affect-your-router/

	Wi-Fi IEEE 802.11 is used by very many devices from smartphones to laptops and tablets to remote sensors, actuators televisions and many more. There are several frequency bands within the radio spectrum that are used for the Wi-Fi and within these there are many channels that have been designated with numbers so they can be identified. Although many Wi-Fi channels are selected automatically, it sometimes helps to have an understanding of the Wi-Fi spectrum, bands, frequencies and the channels with their channel numbers to enable the best performance to be gained. When setting up a Wi-Fi network at home, in the office, or anywhere else, it can help to have a knowledge of the channels and bands available, so that successful Wi-Fi links can be established Also when office Wi-Fi access points are installed, it helps to understand the bands, their characteristics and the channels available. Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

Wi-Fi is aimed at use within unlicensed spectrum - the ISM or Industrial, Scientific and Medical bands. These bands have been internationally agreed and unlike most other bands, they can be used without the need for a transmitting licence. This gives access to everyone to use them freely.

The ISM bands are not only used by Wi-Fi, but everything from microwave ovens to many other forms of wireless connectivity and many industrial, scientific and medical uses.

Whilst the ISM bands are available globally, there are some differences and restrictions that can occur in some countries.

The main bands used for carrying Wi-Fi are those in the table below:

SUMMARY OF MAJOR ISM BANDS

LOWER FREQUENCY MHZ	UPPER FREQUENCY MHZ	COMMENTS
2400	2500	Often referred to as the 2.4 GHz band, this spectrum is the most widely used of the bands available for Wi-Fi. Used by 802.11b, g, & n. It can carry a maximum of three non-overlapping channels. This band is widely used by many other non-licensed items including microwave ovens, Bluetooth, etc.
5725	5875	This 5 GHz Wi-Fi band or to be more precise the 5.8 GHz band provides additional bandwidth, and being at a higher frequency, equipment costs are slightly higher, although usage, and hence interference is less.It can be used by 802.11a & n. It can carry up to 23 non-overlapping channels, but gives a shorter range than 2.4 GHz. 5GHz Wi-Fi is preferred by many because of the number of channels and the bandwidth available. There are also fewer other users of this band.

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

2.4 GHz Wi-Fi channel frequencies

The table given below provides the frequencies for the total of fourteen 802.11 Wi-Fi channels that are available around the globe. Not all of these channels are available for use in all countries.

2.4GHZ BAND CHANNEL NUMBERS & FREQUENCIES

CHANNEL NUMBER	LOWER FREQUENCY MHZ	CENTER FREQUENCY MHZ	UPPER FREQUENCY MHZ
1	2401	2412	2423
2	2406	2417	2428
3	2411	2422	2433
4	2416	2427	2438
5	2421	2432	2443
6	2426	2437	2448
7	2431	2442	2453
8	2436	2447	2458
9	2441	2452	2463
10	2446	2457	2468
11	2451	2462	2473
12	2456	2467	2478
13	2461	2472	2483
14	2473	2484	2495

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

2.4 GHz Wi-Fi channel availability

In view of the differences in spectrum allocations around the globe and different requirements for the regulatory authorities, not all the WLAN channels are available in every country. The table below provides a broad indication of the availability of the different Wi-Fi channels in different parts of the world.

2.4 GHZ WI-FI CHANNEL AVAILABILITY

CHANNEL NUMBER	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
1	✓	✓	✓
2	✓	✓	✓
3	✓	✓	✓
4	✓	✓	✓
5	✓	✓	✓
6	✓	✓	✓
7	✓	✓	✓
8	✓	✓	✓
9	✓	✓	✓
10	✓	✓	✓
11	✓	✓	✓
12	✓	No	✓
13	✓	No	✓
14	No	No	802.11b only

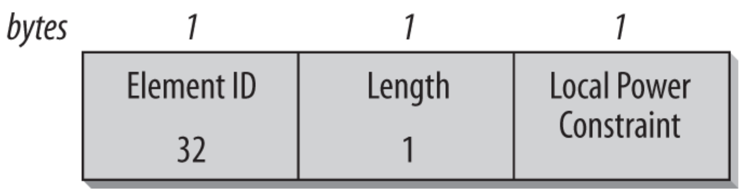
Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

5 GHZ WIFI CHANNELS & FREQUENCIES

CHANNEL NUMBER	FREQUENCY MHZ	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
36	5180	Indoors	✓	✓
40	5200	Indoors	✓	✓
44	5220	Indoors	✓	✓
48	5240	Indoors	✓	✓
52	5260	Indoors / DFS / TPC	DFS	DFS / TPC
56	5280	Indoors / DFS / TPC	DFS	DFS / TPC
60	5300	Indoors / DFS / TPC	DFS	DFS / TPC
64	5320	Indoors / DFS / TPC	DFS	DFS / TPC
100	5500	DFS / TPC	DFS	DFS / TPC
104	5520	DFS / TPC	DFS	DFS / TPC
108	5540	DFS / TPC	DFS	DFS / TPC
112	5560	DFS / TPC	DFS	DFS / TPC
116	5580	DFS / TPC	DFS	DFS / TPC
120	5600	DFS / TPC	No Access	DFS / TPC
124	5620	DFS / TPC	No Access	DFS / TPC
128	5640	DFS / TPC	No Access	DFS / TPC
132	5660	DFS / TPC	DFS	DFS / TPC
136	5680	DFS / TPC	DFS	DFS / TPC
140	5700	DFS / TPC	DFS	DFS / TPC
149	5745	SRD	✓	No Access
153	5765	SRD	✓	No Access
157	5785	SRD	✓	No Access
161	5805	SRD	✓	No Access
165	5825	SRD	✓	No Access

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

adjusting, at said plurality of remote stations,	The base station transmits beacon frames (sounding signal) to the devices nearby at the second frequency (measured/calculated frequency used for the uplink communication). The Power Constraint element included in the beacon frames allows a device (trying to connect to the base station) to determine the local maximum transmit power in the current channel being used for communication and describes the maximum transmit power to remote stations.

responsive to the BS-channel-sounding signal, an initial RS-power level of said plurality of remote stations.	The local maximum transmit power for a channel is defined as the maximum transmit power level specified for the channel in the Country element minus the local power constraint specified for the channel in the Power Constraint element. **Power Constraint** The Power Constraint information element is used to allow a network to describe the maximum transmit power to stations. In addition to a regulatory maximum, there may be another maximum in effect. The only field, a one-byte integer, is the number of decibels by which any local constraint reduces the regulatory maximum. If, for example, the regulatory maximum power were 10 dBm, but this information element contained the value 2, then the station would set its maximum transmit power to 8 dBm (Figure 4-41).  *Figure 4-41. Power Constraint information element* **Power Capability** 802.11 stations are battery powered, and often have radios that are not as capable as access points, in part because there is not usually the need for mobile client devices to transmit at high power. The Power Capability information element allows a station to report its minimum and maximum transmit power, in integer units of dBm (Figure 4-42). Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

Country

The initial 802.11 specifications were designed around the existing regulatory constraints in place in the major industrialized countries. Rather than continue to revise the specification each time a new country was added, a new specification was added that provides a way for networks to describe regulatory constraints to new stations. The main pillar of this is the Country information element, shown in Figure 4-38.

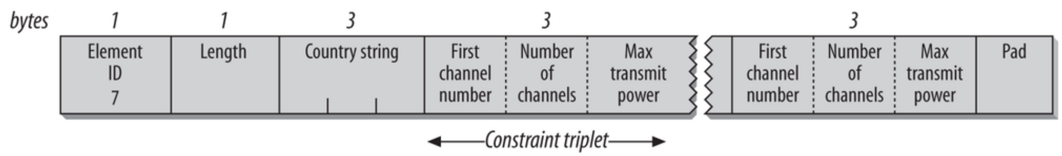


Figure 4-38. Country information element

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

First Channel Number (1 byte)

The first channel number is the lowest channel subject to the power constraint. Channel number assignment for each PHY is discussed in the appropriate chapter.

Number of Channels (1 byte)

The size of the band subject to the power constraint is indicated by the number of channels. The size of a channel is PHY-dependent.

Maximum Transmit Power (1 byte)

The maximum transmit power, expressed in dBm.

Pad (1 byte; optional)

The size of the information element must be an even number of bytes. If the length of the information element is an odd number of bytes, a single byte of zeroes is appended as a pad.

Source: https://www.oreilly.com/library/view/80211-wireless-networks/0596100523/ch04.html#wireless802dot112-CHP-4-FIG-38

9.4.2.14 Power Constraint element

The Power Constraint element contains the information necessary to allow a STA to determine the local maximum transmit power in the current channel. The format of the Power Constraint element is shown in Figure 9-140.

	Element ID	Length	Local Power Constraint
Octets:	1	1	1

Figure 9-140—Power Constraint element format

The Element ID and Length fields are defined in 9.4.2.1.

The Local Power Constraint field is coded as an unsigned integer in units of decibels. The local maximum transmit power for a channel is thus defined as the maximum transmit power level specified for the channel in the Country element minus the local power constraint specified for the channel (from the MIB) in the Power Constraint element.

The Power Constraint element is included in Beacon frames, as described in 9.3.3.3, and Probe Response frames, as described in 9.3.3.11. The use of Power Constraint elements is described in 11.8.5.

9.4.2.15 Power Capability element

The Power Capability element specifies the minimum and maximum transmit powers with which a STA is capable of transmitting in the current channel. The format of the Power Capability element is shown in Figure 9-141.

	Element ID	Length	Minimum Transmit Power Capability	Maximum Transmit Power Capability
Octets:	1	1	1	1

Source: http://read.pudn.com/downloads117/ebook/497259/802.11h-2003.pdf , page 27

	The Minimum Transmit Power Capability field is set to the nominal minimum transmit power with which the STA is capable of transmitting in the current channel, with a tolerance ± 5 dB. The field is coded as a signed integer in units of decibels relative to 1 mW. Further interpretation of this field is defined in 11.8.4. The Maximum Transmit Power Capability field is set to the nominal maximum transmit power with which the STA is capable of transmitting in the current channel, with a tolerance ± 5 dB. The field is coded as a signed integer in units of decibels relative to 1 mW. Further interpretation of this field is defined in 11.8.4. The Power Capability element is included in Association Request frames, as described in 9.3.3.6; Reassociation Request frames, as described in 9.3.3.8; and Mesh Peering Open frame, as described in 9.6.16.2.2. The use of Power Capability elements is described in 11.8.2. Source: [http://read.pudn.com/downloads117/ebook/497259/802.11h-2003.pdf , page 28](http://read.pudn.com/downloads117/ebook/497259/802.11h-2003.pdf)
26. The improvement as set forth in claim 25, with the step of transmitting the plurality of BS-spread-spectrum signals including the step of transmitting the plurality of BS-spread-spectrum signals at the first frequency outside a correlation	See Claim 25 above. 802.11 standard is a half-duplex technology. Hence, a remote station can either receive or transmit at a given time. This implies that when a remote station receives the sounding signal at the second frequency it is not transmitting at the first frequency. Hence, the BS transmits plurality of BS-spread-spectrum signals at a first frequency outside a correlation bandwidth of the plurality of RS-spread-spectrum signals transmitted by plurality of remote stations at a second frequency. **How Duplexing Affects WiFi Routers** WiFi routers are devices that modulate and schedule the flow of information to and from any WiFi-capable electronic device (like a laptop or smartphone) to the Internet, using a specific standard or protocol called IEEE 802.11 which works at half-duplex. WiFi is just the trademark brand for this specific **IEEE** standard (**understand the common WiFi standards**). Source: https://www.makeuseof.com/tag/what-is-half-duplex-and-full-duplex-operation-and-how-does-it-affect-your-router/

bandwidth of the plurality of RS-spread-spectrum signals transmitted by the plurality of remote stations at the second frequency.	Wi-Fi IEEE 802.11 is used by very many devices from smartphones to laptops and tablets to remote sensors, actuators televisions and many more. There are several frequency bands within the radio spectrum that are used for the Wi-Fi and within these there are many channels that have been designated with numbers so they can be identified. Although many Wi-Fi channels are selected automatically, it sometimes helps to have an understanding of the Wi-Fi spectrum, bands, frequencies and the channels with their channel numbers to enable the best performance to be gained. When setting up a Wi-Fi network at home, in the office, or anywhere else, it can help to have a knowledge of the channels and bands available, so that successful Wi-Fi links can be established Also when office Wi-Fi access points are installed, it helps to understand the bands, their characteristics and the channels available. Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

	Wi-Fi is aimed at use within unlicensed spectrum - the ISM or Industrial, Scientific and Medical bands. These bands have been internationally agreed and unlike most other bands, they can be used without the need for a transmitting licence. This gives access to everyone to use them freely. The ISM bands are not only used by Wi-Fi, but everything from microwave ovens to many other forms of wireless connectivity and many industrial, scientific and medical uses. Whilst the ISM bands are available globally, there are some differences and restrictions that can occur in some countries. The main bands used for carrying Wi-Fi are those in the table below: **SUMMARY OF MAJOR ISM BANDS** (see table below) Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

SUMMARY OF MAJOR ISM BANDS

LOWER FREQUENCY MHZ	UPPER FREQUENCY MHZ	COMMENTS
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5725	5875	This 5 GHz Wi-Fi band or to be more precise the 5.8 GHz band provides additional bandwidth, and being at a higher frequency, equipment costs are slightly higher, although usage, and hence interference is less.It can be used by 802.11a & n. It can carry up to 23 non-overlapping channels, but gives a shorter range than 2.4 GHz. 5GHz Wi-Fi is preferred by many because of the number of channels and the bandwidth available. There are also fewer other users of this band.

2.4 GHz Wi-Fi channel frequencies

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2.4GHZ BAND CHANNEL NUMBERS & FREQUENCIES

CHANNEL NUMBER	LOWER FREQUENCY MHZ	CENTER FREQUENCY MHZ	UPPER FREQUENCY MHZ
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3	2411	2422	2433
4	2416	2427	2438
5	2421	2432	2443
6	2426	2437	2448
7	2431	2442	2453
8	2436	2447	2458
9	2441	2452	2463
10	2446	2457	2468
11	2451	2462	2473
12	2456	2467	2478
13	2461	2472	2483
14	2473	2484	2495

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

2.4 GHz Wi-Fi channel availability

In view of the differences in spectrum allocations around the globe and different requirements for the regulatory authorities, not all the WLAN channels are available in every country. The table below provides a broad indication of the availability of the different Wi-Fi channels in different parts of the world.

2.4 GHZ WI-FI CHANNEL AVAILABILITY

CHANNEL NUMBER	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
1	✓	✓	✓
2	✓	✓	✓
3	✓	✓	✓
4	✓	✓	✓
5	✓	✓	✓
6	✓	✓	✓
7	✓	✓	✓
8	✓	✓	✓
9	✓	✓	✓
10	✓	✓	✓
11	✓	✓	✓
12	✓	No	✓
13	✓	No	✓
14	No	No	802.11b only

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php

5 GHZ WIFI CHANNELS & FREQUENCIES

CHANNEL NUMBER	FREQUENCY MHZ	EUROPE (ETSI)	NORTH AMERICA (FCC)	JAPAN
36	5180	Indoors	✓	✓
40	5200	Indoors	✓	✓
44	5220	Indoors	✓	✓
48	5240	Indoors	✓	✓
52	5260	Indoors / DFS / TPC	DFS	DFS / TPC
56	5280	Indoors / DFS / TPC	DFS	DFS / TPC
60	5300	Indoors / DFS / TPC	DFS	DFS / TPC
64	5320	Indoors / DFS / TPC	DFS	DFS / TPC
100	5500	DFS / TPC	DFS	DFS / TPC
104	5520	DFS / TPC	DFS	DFS / TPC
108	5540	DFS / TPC	DFS	DFS / TPC
112	5560	DFS / TPC	DFS	DFS / TPC
116	5580	DFS / TPC	DFS	DFS / TPC
120	5600	DFS / TPC	No Access	DFS / TPC
124	5620	DFS / TPC	No Access	DFS / TPC
128	5640	DFS / TPC	No Access	DFS / TPC
132	5660	DFS / TPC	DFS	DFS / TPC
136	5680	DFS / TPC	DFS	DFS / TPC
140	5700	DFS / TPC	DFS	DFS / TPC
149	5745	SRD	✓	No Access
153	5765	SRD	✓	No Access
157	5785	SRD	✓	No Access
161	5805	SRD	✓	No Access
165	5825	SRD	✓	No Access

Source: https://www.electronics-notes.com/articles/connectivity/wifi-ieee-802-11/channels-frequencies-bands-bandwidth.php